Roystonea borinquena O.F. Cook — Puerto Rican royal palm

Palmae — Palm Family

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Roystonea borinquena O.F. Cook, commonly known as the Puerto Rican royal palm and palma real, is native to Puerto Rico and St. Croix, U.S. Virgin Islands. It is a large palm with a smooth, somewhat thickened trunk (fig. 1). Because it is hardy in city environments and possesses a clean-lined beauty, the Puerto Rican royal palm has become a very important ornamental in Puerto Rico and nearby islands. The fruit it produces in abundance is an important fat-rich food for many bird species.

HABITAT

Native Range

The Puerto Rican royal palm is native to Puerto Rico, Vieques Island (Puerto Rico), and St. Croix in the U.S. Virgin Islands *(11)*. It was noted in the disturbed natural forest covering Sage Mountain in Tortola, British Virgin Islands, in the 1940's and may be native to that Island *(5)*. It is cultivated and possibly has become naturalized in St. Thomas and St. John, U.S. Virgin Islands, and in the British Virgin Islands (fig. 2).

Climate

Puerto Rican royal palms reproduce and survive best in a moist climate. Natural reproduction normally occurs in areas that have 1250 to 2500 mm of precipitation per year; rarely does it occur naturally outside this range. This annual precipitation corresponds to the subtropical moist and subtropical wet life zones (sensu Holdridge *9*). During the short dry season (February and March), the precipitation generally drops below 80 mm/month. The native range is warm (mean annual temperature of about 25 °C) and frost free, with only minor temperature fluctuations during the year.

Soils and Topography

The Puerto Rican royal palm grows on most of the moist, well-drained soils within its native range. It can also tolerate poorly drained soils *(14)*. The species is fairly tolerant of low nutrient conditions and can grow reasonably well on partially compacted fill dirt, but some subsoils exposed by erosion or scalping result in poor growth. The soil orders Ultisols, Alfisols, Inceptisols, and Oxisols are important habitat. Common parent materials are limestone and weathered igneous rock. The most aggressive natural reproduction in advanced secondary forests occurs on slopes and in valleys of moist limestone hills; Puerto Rican royal palms may have been largely restricted to this habitat before large-scale forest cutting was begun *(8)*. They may also exist in natural stands at the periphery of fresh-water wetlands. In drier areas of its range, the species often grows

Figure 1. — *A transplanted Puerto Rican royal palm* (Roystonea borinquena) *in a roadside environment.*

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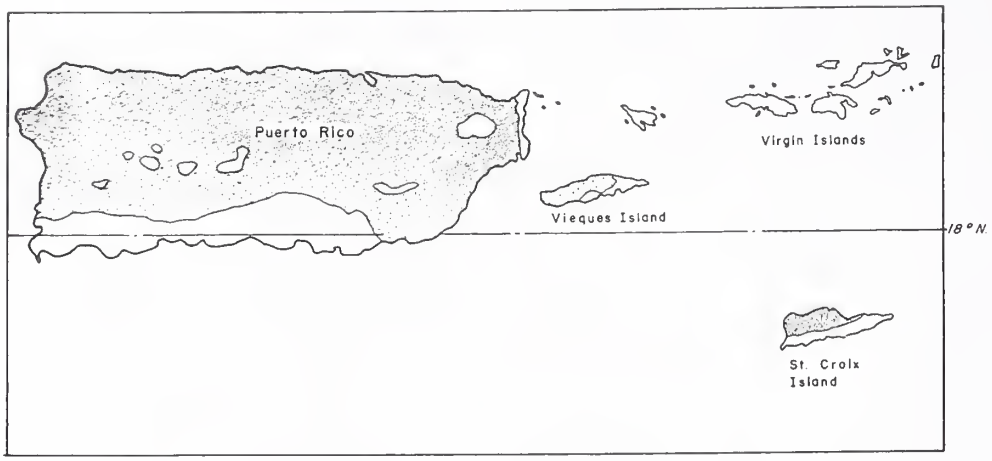

Figure 2. — *The current natural range of the Puerto Rican royal palm* (Roystonea borinquena), *as represented by the shaded areas.*

in clusters in moist coves, near seeps, and along streams. The Puerto Rican royal palm grows on level to steep topography from near sea level to 600 m or more in elevation.

Associated Forest Cover

An old-field site occupied by Puerto Rican royal palms in central Puerto Rico also supported *Zanthoxylum martinicense* (Lam.) DC., *Cupania americana* L., *Citharexylum fruticosum* L., *Mangifera indica* L., *Petitia domingensis* Jacq., and *Spathodea campanulata* Beauv. (author, personal observation). Puerto Rican royal palms were reported in a coastal wetland community dominated by *Pterocarpus officinalis* Jacq.; lesser-statured associates were *Bucida buceras* L., *Clusia rosea* Jacq., *Inga fagifolia* (L.) Willd., *Calophyllum calaba* Jacq., *Andira inermis* (W. Wright) HBK., *Cecropia peltata* L., *Licaria parvifolia* (Lam.) Kostermans, and *Manilkara bidentata* (A. DC.) A. Chev. *(1)*. Sites of Puerto Rican royal palms on Vieques Island, Puerto Rico, may contain *Andira inermis* (W. Wright) HBK., *Hura crepitans* L., *Samanea saman* (Jacq.) Merrill, *Z. martinicense, Mangifera indica,* and *Citharexylum fruticosum* (author, personal observation).

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—Flower buds form at the base of the leaves (sometimes called fronds) and elongate under the leaf sheath. Encasing the developing flower is a boat-shaped sheath (spathe) 0.9 to 1.5 m long that emerges as the leaf falls. The flower cluster, a panicle, bears many flowers of both sexes. The male flowers of each tree open and fall before the female flowers of the same tree open *(11)*, ensuring cross pollination. The greenish-yellow fruits grow to about 13 mm in length and 10 mm in diameter and eventually ripen to a fleshy consistency while turning to a brownish-red or brownish-purple color. Cook *(8)* and subsequent authors described the ripe fruits as yellow brown. Perhaps this misobservation occurred because fruits tend to ripen singly and fall or are eaten by birds, leaving the overall cluster the same greenish-yellow color. Ninety-nine recently fallen fruits averaged 0.88 ± 0.09 g per fruit (author, personal observation). About 1 year passes between emergence of the flower sheath and ripening of the fruit.

Puerto Rican royal palms flower throughout the year. Flowering and fruiting begin at 7 to 14 years of age in vigorous, open-grown trees (author, personal observation). Open-grown trees of low vigor may never fruit. In forest stands, intermediate and suppressed Puerto Rican royal palms do not fruit, codominant trees sometimes fruit, and dominant trees fruit most of the time.

Seed Production and Dissemination.—Fruit and seed production of individual trees can be massive. Potentially, one flower cluster per leaf can be produced. An average of 12.0 leaves are produced yearly by trees in urban environments in Puerto Rico (author, personal observation). Of course, not all leaves are accompanied by flowers nor do all trees produce flowers. A survey of 100 trees large enough to bear fruit revealed that 35 percent were without fruit clusters. The remainder bore an average of 3.2 ± 0.2 fruited clusters per tree. Each of three panicles examined yielded 6,000 to 12,000 fruits (author, personal observation). Each fruit contains one hard seed 8 to 10 mm in length and about 7 mm in diameter. A sample of 100 air-dried seeds averaged 0.34 ± 0.01 g per seed or about 3,000 seeds per kilogram (author, personal observation).

The fruit pericarp is an oily, energy-rich food that is important to many bird species *(13)* that scatter the seeds widely. Seeds are also dispersed by rodents, domestic animals, gravity, water, and machinery.

Seeds for propagation are easily collected in quantity from the ground below open-grown trees. The seeds can be stored in sealed containers at room temperature for at least a month or two. Refrigeration is advisable for longer storage.

Seedling Development.—Propagation from seeds is the normal method of producing royal palm plants. Hypogenous germination begins about 14 days after sowing and may continue for 2 months. Trials by the author with peat, filter paper, and fine sand (at different times and with different seedlots) resulted in germinations of 3, 28, and 80 percent, respectively. Treatment of seeds with boiling water, by mechanical scarification, and by soaking them in hormone solutions resulted in no significant increases in germination. In the absence of more thorough tests, sowing in fine sand with no pretreatment is recommended.

The radicle (root) emerges first. The new shoot (cotyledon leaf) emerges about 3 weeks later for seeds buried 2 cm deep. Nursery seedlings should be grown in full sunlight *(7)*. Seedlings grown in the nursery by the author reached about 30 cm in height 6 months after sowing, about 40 cm in 8 months, and about 90 cm in 15 months. Puerto Rican royal palms can be grown to heights of 1.5 m or more without difficulty in 4-liter containers. Seedlings in containers can be transplanted at any size but will need complete protection from weeds and grass until they have formed a stem and are well above the competition. Wildlings can be successfully transplanted, but a period of recover under shade in containers is necessary before they can be outplanted.

The author is not aware of any forestry or conservation plantings of the species; however, many thousands of individual palms have been transplanted as ornamentals. Although Puerto Rican royal palms are now grown in nurseries, the standard method of acquiring and establishing trees for landscaping purposes is to dig up large trees from forest or farm sites with a backhoe, transport them (without any particular protection) to new sites, plant the trees and install props to hold them upright, and water them frequently until new root systems are formed. Surprisingly, little mortality results from this seemingly rough treatment. The large amount of water stored in the thick trunks may help sustain transplanted trees until they can develop new roots. Very high mortality commonly occurs when young trees with only basal leaves or very short trunks are moved directly to new sites. Successful transplanting could probably be achieved by excavating an earth ball with the small palms, protecting them against desiccation during transportation, watering them frequently, and placing artificial shade over them for a few weeks after transplanting.

Vegetative Reproduction.—There are no reports of artificial vegetative reproduction of this species.

Sapling and Pole Stage to Maturity

Growth and Yield.—As Puerto Rican royal palms grow beyond the seedling stage, they develop a basal bulb and rapidly increase in height. One hundred urban trees averaged 12.4 ± 0.6 leaf scar rings between the first and second meter of the trunk, measured from ground level (author, personal observation). The average number of leaves shed per year (about 12) indicated that palms grow a meter per year during this period if young palms produce leaves at the same rate as somewhat older palms monitered for leaf production. Leaf scar rings became much narrower at 5 to 9 m on the trunk at the point where fruiting began. About the time fruiting begins, a thickening develops at midheight on the bole. Slow growth continues until the tree finally weakens and dies at perhaps 80 to 110 years of age.

Open-grown Puerto Rican royal palms rarely reach 20 m in height, presumably because early fruit production slows down height growth. Forest-grown trees frequently exceed 20 m in height. The tallest of this species known to the author measures 26.5 m in height. Stem diameters of mature Puerto Rican royal palms apparently depend on vigor and range from about 25 to 70 cm.

Crown diameters of 33 urban Puerto Rican royal palms, measured in four directions to the actual crown edge, averaged 3.5 m. The diameter of the crown extremity would be closer to 4 m. The maximum theoretical basal area of a pure stand of Puerto Rican royal palms at regular spacing, with crowns edge to edge and an average stem diameter of 40 cm, is 78.5 m^2/ha. Actual stands contain a small proportion of palms and have much lower stocking. Nine secondary moist forest stands containing groups of Puerto Rican royal palms were sampled in 10-m-radius plots, with each plot being centered on a palm clump. Total basal area of the stands ranged from 33 to 46 m^2/ha, and the basal area of palms ranged from 9 to 31 m^2/ha (author, personal observation). Scattered individual trees are more typical for the species. The Puerto Rican royal palm was the eighth most important species in terms of basal area (about 1 percent of the total) in a survey of Puerto Rican timberland *(6)*.

Rooting Habit.—A thin, stiff taproot with laterals at various depths is produced by new seedlings. The taproot is eventually encompassed by a mass of adventitious lateral roots that develop from the base of the stem; these roots extend widely and reach deep into the soil. They remain slender and do not lift sidewalks or curbs, but they may enter sewer pipes *(2)*.

Reaction to Competition.—The Puerto Rican royal palm has an intermediate tolerance to shade but a low tolerance to competition. On suitable sites, thousands of seeds may germinate and produce one- or two-leafed plants that are easily mistaken for grass. Most of these will eventually succumb to competition from understory vegetation. Occasionally, under light to moderate shade or in openings, an individual will grow a trunk and eventually enter the canopy. Chances for survival are greatly increased under shade and in the sun if ground-level vegetation is controlled. Favorable conditions are so rarely met that extensive stands do not form, and patches of Puerto Rican royal palms are uncommon.

Density of natural royal palm seedlings in a 6-year-old *Albizia lebbeck* (L.) Benth. plantation was 0.05 plants per square meter.[1] Over a 15-month period, there was no mortality among the seedlings, which ranged in height from 16 to 50 cm; height growth averaged only 9.9 cm/yr during that period.

Once past the seedling stage, Puerto Rican royal palms are sensitive to competition from each other. Vigorous individuals in single rows spaced too close together will sup-

[1]Personal communication with John Parrotta, research forester at the Institute of Tropical Forestry, U.S. Department of Agriculture Forest Service, Southern Forest Experiment Station, Río Piedras, PR 00928-2500.

press the weaker ones. For row or group plantings, a spacing of a least 4 m is recommended.

Human disturbance has undoubtedly extended the range and increased the abundance of the species *(8)*. The processes involved almost certainly include sparing royal palms when slashing forest stands, planting, creating favorable habitat for reproduction, and protecting new seedlings. In certain areas of secondary forests in Puerto Rico, Puerto Rican royal palms exist only on abandoned farm sites. Puerto Rican royal palms easily survive hurricanes, which enables this relatively short-statured species to reach a dominant position in the forest canopy and produce seeds.

Damaging Agents.—Although the Coleopteran (beetle) *Phyllophaga vandinei* Smyth occasionally causes significant damage by feeding on the foliage *(12)*, Puerto Rican royal palms apparently have no serious insect enemies. Seedlings in pastures are consumed by grazing animals. Wood in use (construction, etc.) is very susceptible to attack by the drywood termite *Cryptotermes brevis* (Walker) *(16)*. The hard, outer sheath of trunkwood appears to have some rot resistance.

As stated previously, the Puerto Rican royal palm is one of the most resistant trees to wind (storm) damage. Hurricane Hugo, with gusts up to 145 km/h in San Juan, Puerto Rico, broke or toppled less than 1 percent of the palms. Only a few died as a result of partial to almost complete defoliation (author, personal observation).

SPECIAL USES

The Puerto Rican royal palm is principally used today as an ornamental. Its ability to grow in a limited soil volume (as between sidewalk and curb), its resistance to air pollution, the ease with which large individuals can be transplanted, and its clean-lined beauty have made it one of the favorite street and landscaping trees in Puerto Rico and U.S. Virgin Islands. Although it is no longer recognized as such, the Puerto Rican royal palm was once (1902) voted the State tree of Puerto Rico *(3)*.

Puerto Rican royal palms are very important to many bird species as a food source and as a nesting site. Domestic animals, particularly hogs and chickens, consume the fruits. The seeds were formerly collected and ground for hog feed *(4)*. The fruits and seeds contain high quantities of fat and other nutrients (table 1). During shortages of feed, farmers sometimes cut the palms and feed cattle the leaves and the soft pith from the center of the stem. The Puerto Rican royal palm also produces heart-of-palm (tender leaves and stems in early development stages) that people eat both raw and cooked. In addition, the flowers are an important source of nectar for honeybees *(11)*.

Boards cut from the hard outer shell of the trunk were formerly used to cover floors and sides of houses. The hard outer portion is about 30 mm thick at the base of the tree and thins higher up to 15 to 20 mm. The flexible leaf sheaths were also used as house siding. Both the flattened leaf sheaths and the leaves were used to thatch houses and barns. The leaf blades were also woven into chair seats and backs *(11)*. The spathes usually fall with the opening in an upright position and afterwards collect a liter or two of rain water. Spathes serve as watering places for birds and small animals and as breeding places for frogs and mosquitos. Spathes were formerly used as disposable bowls and toys for children.

Table 1.—*Concentrations of fat and other nutrients in dry fruits and seeds of the Puerto Rican royal palm*

Nutrient and component	Concentration*	
	Fruit	Seed
	Percent	
Fat (lipids)	44.38*	19.65
Capric acid	(0.00)	(0.46)
Caprylic acid	(0.00)	(0.74)
Lauric acid	(0.08)	(3.04)
Linoleic acid	(2.03)	(0.81)
Linolenic acid	(0.07)	(0.00)
Myristic acid	(0.03)	(0.92)
Oleic acid	(10.35)	(2.60)
Palmitic acid	(4.16)	(0.74)
Palmitoleic acid	(0.10)	(0.00)
Stearic acid	(0.75)	(0.25)
Starch	6.48	10.98
Reducing sugar	1.30	0.80
Nonreducing sugar	0.23	1.59
Protein (Nx6.25)	3.19	7.12
Ash	9.45	2.82
Ca	(1.38)	(0.15)
P	(0.09)	(0.18)
K	(1.81)	(0.47)
Mg	(0.31)	(0.09)
Fiber (by difference)	34.97	57.04
Total	100.00	100.00

*Unpublished data collected by the author. Figures in parentheses are concentrations of certain components of the nutrient listed just above them.

GENETICS

There are 10 to 12 species of the genus *Roystonea* that range from Florida and Mexico through northern South America *(10)*. The Puerto Rican royal palm is closely related to the Cuban royal palm, *R. regia* (Kunth) O.F. Cook, and is difficult to distinguish from it. Members of the genus normally have n=18 chromosomes *(15)*. Apparently, there is no need for genetic selection or breeding of the Puerto Rican royal palm under current usage.

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